Attorney Docket: 037068.56210US
English Translation

DISC BRAKE COMPRISING AN ELECTROMOTIVELY ACTUATED ADJUSTING DEVICE, AND CONTROL METHOD

The invention relates to a disc brake according to the preamble of Claim 1 and to a method of controlling this disc brake.

A pneumatically actuated disc brake of this type is known from International Patent Document WO02/14708. The disc brake disclosed in that document has a caliper which encompasses a brake disc. It also has an application device arranged in the caliper on the side of the brake disc. This application device particularly has a rotary lever. For the compensation of brake pad wear, two electromotively actuated adjusting devices respectively are provided on each side of the brake disc. One electric motor respectively on each side of the brake disc, as an electric-motor drive, jointly drives the two adjusting devices on each side of the brake disc.

Like the caliper of the present invention, the caliper of the above state of the art can be constructed as a fixed, hinged and/or sliding caliper. Mixed forms of these systems are also conceivable as well as solutions in which the caliper and/or the brake disc can deform by a certain path during applications of

the brake.

If the caliper is constructed as a fixed caliper, the brake disc could be constructed as a sliding disc which is displaceable by the amount of the working stroke of the brake on a wheel hub.

In the case of pneumatically actuated disc brakes, the parking and emergency braking function or brake is normally implemented by a spring-loaded cylinder which is combined with the service brake cylinder to form a constructional unit, the so-called combination cylinder. These systems operate very reliably. Their disadvantage is the large required space, the considerable weight and the high manufacturing costs.

It is therefore being considered to implement the parking braking function in that the brake is actuated by way of the service brake cylinder and this braking position is held by a mechanical locking. This locking can take place at the brake cylinder itself, at its actuating plunger or at an actuating element of the application device of the brake (for example, a brake lever).

It is a disadvantage of these solutions that no gradual braking effect can be achieved. Although the parking braking function per se can be implemented, further demands on the

emergency braking function are not met.

On the other hand, developments are taking place to replace the mechanical wear adjusting systems of pneumatically actuated brakes, particularly disc brakes, by electromotively actuated and electronically controlled systems.

Likewise, solution suggestions exist which concern an electromotive actuating mechanism which acts directly or by way of the service brake cylinder upon the application device, particularly a rotary lever.

These solutions have the disadvantage that an additional high-expenditure electronic control is required as a result of the additional electromotive actuating system.

Based on this background, the invention has the object of implementing in a cost-effective and constructively simple manner the parking braking and/or emergency braking function - this also includes halt braking functions and the like - on a disc brake which can be pneumatically actuated.

The invention achieves this task by means of the object of Claim 1.

Accordingly, the at least one electromotively actuated adjusting device is designed such that, in addition to carrying out its adjusting function, it can also be used as a parking and/or emergency brake. As a result, the electromotively actuated or electromechanical wear adjusting system is in an advantageous and cost-effective manner also utilized for the implementation of the parking and/or emergency braking function.

It is only necessary to dimension the electromotive drive or drives of the adjusting device(s) such that it also meets the requirements of the parking and/or emergency braking function.

Furthermore, only a control device - a control computer -, which controls the adjusting devices or their motors, in a supplementary manner also has to be designed for carrying out a suitable controlling of the electromotive adjusting device for implementing the parking and/or emergency brake.

Since the same mechanical elements are used for the adjusting devices as well as for the parking and/or emergency braking function, and functions of the electronic control can be used jointly, the parking and/or emergency braking function can virtually be used as an "addition" to the electromotively actuated adjusting device, which is present anyhow, in an extremely cost-effective manner which nevertheless has a reliable

effect.

Thus, an electromotive parking and/or emergency brake (also conceivable with the inclusion of the halt function) is implemented, which requires only very low expenditures with respect to the space, the weight and the manufacturing costs.

In particular, the electromotive drive of at least one of the adjusting device or of the at least one adjusting device is dimensioned such that it can be used as a parking and/or emergency brake. It is possible that a slightly more powerful electric motor will have to be used than when the adjusting device is used only for the adjusting per se.

Advantageously, apart from the motors, the other mechanical components of the adjusting device are also dimensioned such that they can be used as a parking and/or emergency brake.

Furthermore, electrical/electronic assemblies of the wear adjusting system also have to be designed for the use of the adjusting devices as a parking and/or emergency brake.

If the adjusting devices are arranged on both sides of the disc brake, only one of them could be used for carrying out the parking and/or emergency braking function. It is particularly

advantageous to utilize an adjusting device on the actuation side of the brake for implementing the parking and/or emergency braking function.

Constructively, the driving motor could be accommodated in the or at the or - particularly advantageously with respect to space - below the brake housing or caliper and could engage by way of a coupling gear in the transmission gearing.

The invention also provides a method of controlling particularly the disc brakes according to the invention. Accordingly, the parking and/or emergency braking function is implemented while using or at least while supplementarily using the electromotive adjusting device. The electromotive adjusting device implements this function either alone or partially or is at least utilized in some form for or during the implementation of this function.

Preferably, in the case of disc brakes with a wear adjustment on both sides, the second adjusting device not required for engaging the parking and/or emergency brake is also controlled for reducing the release play, thus for reducing the application stroke of the first adjusting device.

For reducing the power demand of the electromotive drive

when engaging the parking brake, the pressure in the service brake cylinders could be reduced (preferably to the still required extent).

According to a variant, for determining the pressure of the service brake cylinders required for the temporary stopping of the vehicle, in a simple manner, information of inclination sensors and/or other information present in the electronic braking system is used.

The information preferably comprises changes of the output signal of axle load sensors when driving on gradients and/or stored data of the preceding stopping operation on the gradient, such as brake pressure or achieved deceleration. By means of this information, the best possible controlling is then determined.

For reducing the power demand of the electromotive drive of the adjusting device for implementing the parking and/or emergency brake.....(?) the brake cylinder pressure, it is conceivable that the brake pressure is reduced only at individual wheels by way of an electronic control device, for example, for each axle or each wheel and, after the engaging of the parking brake at this wheel or at the wheels of this axle, the brake pressure at these wheels is raised again and in this manner the

parking brake is engaged successively at the different axles or wheels of the vehicle.

It is also expedient to generate an electric desired-value signal in a simple manner for controlling the parking and/or emergency brake in the case of an operating element actuated by the driver or by means of an electronic control device, particularly by means of the signals of gradient and/or force sensors, and to convert this desired value in the brake-integrated control to an adjusting path of the adjusting screws, this adjusting path being dimensioned such that a defined spreading-open of the caliper is adjusted which corresponds to the tension force of the caliper which is necessary for achieving the defined desired value.

According to another variant, a desired-value definition is obtained from the signal of a pressure sensor for controlling the parking and/or emergency brake in the case of vehicles which are equipped only on one axle, for example, the front axle, with an integrated electromotive parking and/or emergency brake and with a conventional spring brakes on the driving axle, which pressure sensor detects the pressure acting upon the spring brakes. In this case, preferably the conventional hand brake valve is retained as the operating element, and the desired value for the electromotive actuation is generated from the control pressure.

Additional advantageous further developments are indicated in the other subclaims.

In the following, the invention will be described in detail by means of embodiments.

Figures 1 and 2 are two mutually perpendicular sectional views of a disc brake.

The basic construction of the disc brake may correspond to the construction described in international patent document PCT/EP01/09370. However, the electric motor should be dimensioned to be so powerful that it meets the additional demands on the parking and/or emergency brake or the like.

According to Figures 1 and 2, the pneumatically actuated disc brake 1 has a caliper 2 which frames a brake disc 3 in its upper peripheral area. In addition, an application device 15 is arranged in the caliper 2 at least on one side of the brake disc, particularly with an eccentrically disposed rotary lever 4 to which the actuating plunger 5 of the brake cylinder 6 is applied. As an example, Figure 1 shows a fixed caliper with an axially movable brake disc 3 (not visible), so that the application device first presses pressure pieces 12 (or a pressure piece

plate) with a first brake pad 13 in the direction of the brake disc 3 and then presses these against the additional brake pad 14 on the other side of the brake disc 3.

While the application takes place pneumatically, for the adjustment, preferably at least one (here two) electromotively driven adjusting devices 7a,b and 8a,b respectively are provided on each side of the brake disc 3.

Preferably at least one electric motor 9, 10, for example, an EC motor, respectively is used as a drive of the two adjusting devices 7, 8 respectively on each side of the brake. It is also conceivable that, in each case, only one electromotively driven adjusting device 7, 8 is provided on each side of the brake disc or that only a single adjusting device is arranged on one side of the brake disc (for example, in the case of a sliding or hinged caliper concept, for which the invention is also suitable). Here, the electric motors are accommodated on, particularly under the caliper (as an alternative, they can also be mounted in or under it) and engage by way of a coupling gear 16 (here, only on the application side) in the transmission gearing 17 of the adjusting devices.

In practice, the electric motors can or will be slightly larger than in the representation of Figure 1 in order to also

implement the adjusting function because in this case they are not only used for the adjusting function but also for implementing the parking brake and/or halt brake, etc.

As an alternative, two or more adjusting devices 7, 8 may also be constructed on each side of the brake disc.

According to the invention, the electromotively driven adjusting device 7, 8 is not used for implementing the adjusting function, thus, for compensating the brake pad wear, but also in some manner during the implementation or even completely for the implementation of the parking and emergency braking function.

All elements of the actuating mechanism of the electromotive parking and emergency brake are already present in the electromotive wear adjusting devices and/or on the disc brakes. These are:

- the electromotive drive 9, 10;
- the reduction and synchronization gear 17 of the adjusting devices 7, 8; and
- the adjusting screw system 11.

Furthermore, the following elements also always exist in a separate control unit or in a control unit on or in the disc brake:

- Basic elements of the electronic circuit (power supply unit, EMV (electromagnetic compatibility) protection, etc.);
- a power control of the electric drive;
- a position control of the electric drive;
- a logic circuit of the electronic hardware (microprocessors, etc.);
- a basic control software (monitoring functions for the electromotive drive and the electronic system) etc.

For implementing the electromotive parking and emergency brake by means of the adjusting devices with the electromotive drive, only the dimensioning of the electric motor and of the transmission and of the electronic power system have to be adapted to the higher power demand of the parking and emergency brake, and the additional software has to integrated for the implementation of the parking and /or emergency braking function.

By way of an electric line, the brake is supplied with voltage and/or data. In particular, it is connected to an electronic control unit (EBS control unit or the like), which takes over the control of the disc brakes.

Reference Symbols

Disk brake	1
caliper	2
brake disc	3
rotary lever	4
actuating plunger	5
brake cylinder	6
adjusting device	7,8
electric motor	9,10
adjusting screw system	11
pressure pieces	12
brake pad	13
brake pad	14
application device	15
coupling gear	16
transmission gearing	17